Hopper Discharge Systems

AUMUND

Plant design

Hoppers, silos or dumping stations require discharge equipment to adapt to the varying flow properties of bulk materials and to the given design criteria.

The bulk materials' behavior during storage and discharge generally depends on the particle size, the degree of homogeneity and the moisture content which may be subject to seasonal fluctuations. These features are essential when designing the hopper and the cross section of the hopper outlet.

The illustrations show a selection of layouts for a rail wagon unloading station with a rectangular hopper. The hopper inside is either lined with wear-resistant material or fitted with a polished lining to prevent cohesive material from sticking to the hopper walls.

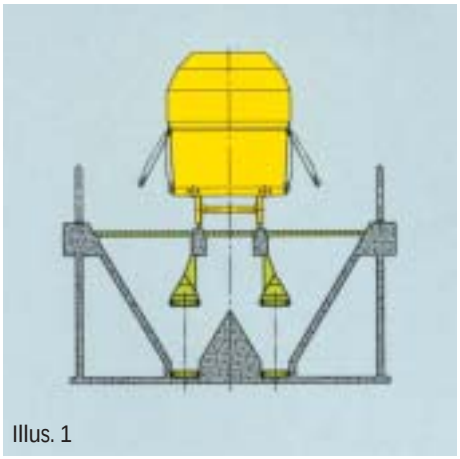
Illus. 1 - The special design of the **drag chain conveyor, type TKF**, in this example used for discharge of raw coal, allows to build the receiving hopper with a relatively small depth.

Illus. 2 shows an alternative featuring an **armoured chain conveyor, type PKF**, with low construction height and tight connection to the hopper.

Illus. 3 - Unloading of various bulk materials performed with a **heavy-duty pan conveyor, type KZB-S**. To reduce the vertical loads during discharge of the material into the pan conveyor, an impact relief cone-shaped girder is built into the hopper.

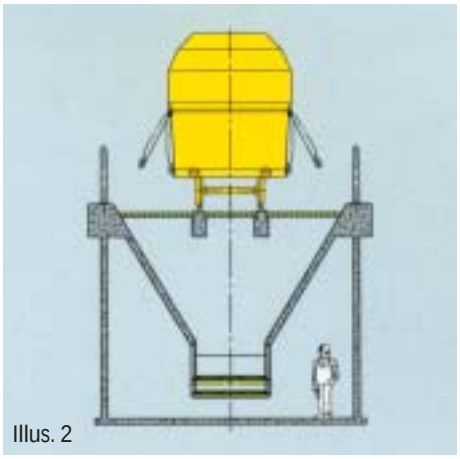
Illus. 4 demonstrates how silos or rectangular hoppers of considerable length can be discharged with a **rotary discharge machine, type RDM**, requiring only little operating power.

The correct choice of the discharge equipment is a major issue for the design of the wagon tipping station.



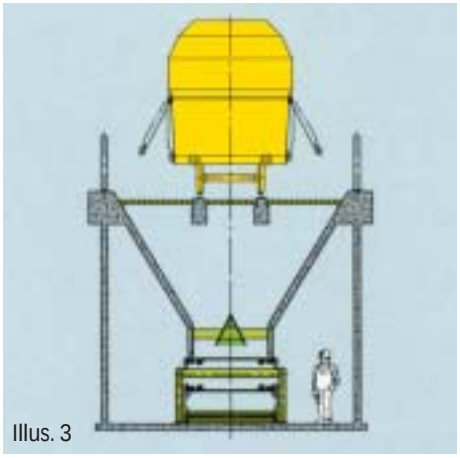
Hopper discharge with drag chain conveyor, type TKF


Drag chain conveyor, type TKF



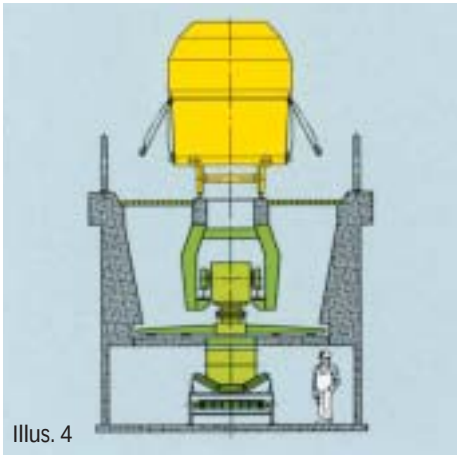
Hopper discharge with armoured chain conveyors, type PKF


Armaured chain conveyor, type PKF



Hopper discharge with deep drawn pan conveyor, type KZB 250-S


Hopper with deep drawn pan conveyor, type KZB 250-S

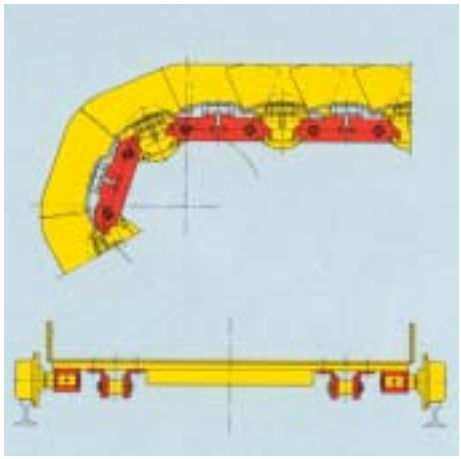


Hopper discharge with rotary discharge machine, type RDM


Rotary discharge machine, type RDM

Plant design

Arched plate conveyor, type BPB



Arched plate conveyor - arched shape

Arched plate conveyor, type BPB

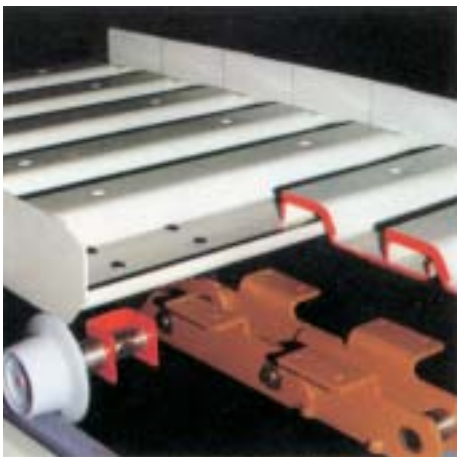
The apron feeder with arched plates is the perfect equipment for conveying of sticky raw materials such as gypsum, anhydride, clay or a marl-clay mix. The arched plates of the feeder form a surface perfectly matching the drive and tail sprockets, hence allowing cleaning of the plates with a scraper. Fitted with a weighing rail and a frequency controlled drive unit, this conveyor may be used for proportional feeding of grinding units.

Chart of conveying arched plate conveyor type BPB

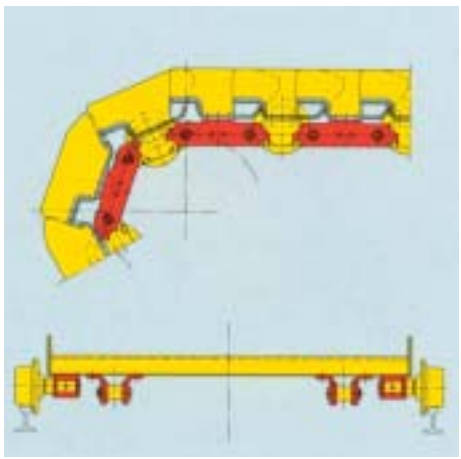
Conveyor section		Theoretical conveying capacity m^3/h			
Width P/w (mm)	Standard layer height H (mm)	Conveying speed (m/s) 0.05	0.10	0.15	0.20
800	400 +/- 100	50 +/- 12	100 +/- 25	151 +/- 37	201 +/- 50
1.000	400 +/- 100	64 +/- 16	129 +/- 32	194 +/- 48	259 +/- 64
1.200	600 +/- 100	118 +/- 19	237 +/- 39	356 +/- 59	475 +/- 79
1.400	800 +/- 100	187 +/- 23	374 +/- 46	561 +/- 70	748 +/- 93
1.600	800 +/- 100	216 +/- 27	432 +/- 54	648 +/- 81	864 +/- 108
1.800	800 +/- 100	244 +/- 30	489 +/- 61	734 +/- 91	979 +/- 122
2.000	800 +/- 100	273 +/- 34	547 +/- 68	820 +/- 102	1.094 +/- 136
2.200	800 +/- 100	302 +/- 37	604 +/- 75	907 +/- 113	1.209 +/- 151
2.400	800 +/- 100	331 +/- 41	662 +/- 82	993 +/- 124	1.324 +/- 165

min. layer height 2.5 x max. particle size
max. layer height = plate width 400-1.000 mm
Conveying speed 0-0.2 m/s at choice
The actual conveying capacity depens on the particle size and the layer height chosen. Capacity reduction factor 0.9-1.0
Thickness of the plate 8/10 mm

Conveying capacity BPB



Deep drawn pan conveyor, type KZB 250-S



Deep drawn pan conveyor - pan profile

Deep drawn pan conveyor, type KZB 250-S

The deep drawn pan conveyor is preferably employed for longer hoppers and conveys raw coal, coke and cement clinker. The pan profile provides a high resistance against buckling and consequently accepts considerable hopper loads. Where adequate, the plate edges may be fitted with wear-resistant protective caps. The traction force required to reclaim the material from the hopper is calculated on the basis of the hopper geometry. Chains featuring breaking loads up to 2 x 1,800 kN are available for the various applications with this conveyor.

If spillage collection is required, a scraper chain can be fitted underneath the pan conveyor. Scraper conveyors may be arranged either underneath the conveyor or around the tail station allowing to recycle the spillage onto the pan conveyor.

Chart of conveying capacity type KZB 250-S and type BPB-S

Conveyor section		Theoretical conveying capacity m^3/h			
Width P/w (mm)	Standard layer height H (mm)	Conveying speed (m/s) 0.05	0.10	0.15	0.20
1.000	400 +/- 100	64 +/- 16	129 +/- 32	194 +/- 48	259 +/- 64
1.200	600 +/- 100	118 +/- 19	237 +/- 39	356 +/- 59	475 +/- 79
1.400	800 +/- 100	187 +/- 23	374 +/- 46	561 +/- 70	748 +/- 93
1.600	1.000 +/- 100	270 +/- 27	540 +/- 54	810 +/- 81	1.080 +/- 108
1.800	1.000 +/- 100	306 +/- 30	612 +/- 61	918 +/- 91	1.224 +/- 122
2.000	1.000 +/- 100	342 +/- 34	684 +/- 68	1.026 +/- 102	1.368 +/- 136
2.200	1.000 +/- 100	378 +/- 37	756 +/- 75	1.134 +/- 113	1.512 +/- 151
2.400	1.000 +/- 100	414 +/- 41	828 +/- 82	1.242 +/- 124	1.656 +/- 165
2.600	1.000 +/- 100	450 +/- 45	900 +/- 90	1.350 +/- 135	1.800 +/- 180
2.800	1.000 +/- 100	486 +/- 48	972 +/- 97	1.458 +/- 145	1.944 +/- 194
3.000	1.000 +/- 100	522 +/- 52	1.044 +/- 104	1.566 +/- 156	2.088 +/- 208

min. layer height 2.5 x max. particle size
max. layer height = plate width - 200 mm
Conveying speed 0-0.2 m/s at choice
The actual conveying capacity depens on the particle size and the layer height chosen. Capacity reduction factor 0.9-1.0.
Thickness of the plate type KZB-S 6/8 mm
type BPB-S 20/30/40/50/60/70/80 mm

Conveying capacity type KZB-S and type BPB-S

Arched plate conveyor, type BPB-S type BPB-SF

These heavy duty apron feeders are often arranged underneath tipping stations to transport raw materials to the crushing plant. The heavy duty design of the arched plate conveyor perfectly suits raw materials received in unconditioned state directly from the quarry, such as limestone lumps with an overall length of more than 1,000 mm, gypsum and various other bulky raw materials.

The strength of the conveyor plates depends on the expected particle size, the capacity and the dimensions of the hopper. The thickness, ranging from 20 to 80 mm, is chosen according to the application. The caterpillar chains' size is chosen to suit the plate thickness. Two chains with a breaking load of up to 2 x 3,600 kN are fitted to the conveyor plates. The combination of heavy duty chains and plates accommodates all applications and allows to build the conveyor with a plate width of up to 3,000 mm. A high fitting accuracy of the plates, milled plate edges and cranked side boards provide tight overlapping and reduce spillage.

The vertical loads define the type of rollers to be used :

Type BPB-S with outboard rollers and heavy field rails.

Type BPB-SF with heavy-duty rollers arranged underneath caterpillar chains

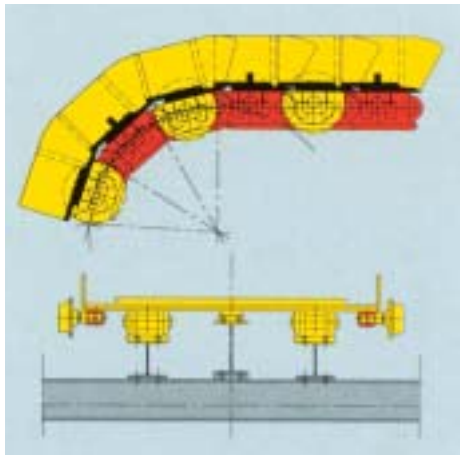
For size determination and related conveying capacities refer to page 3.

Impact relief girders arranged in the feed area account for often unknown impact loads. A lubrication system ensures automatic lubrication of the impact relief girders.

Drive shaft with toothed sprocket

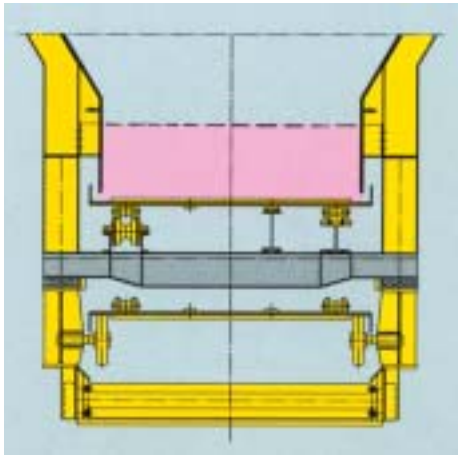
Impact table with shock absorbers

Apron Feeder, type BPB-S

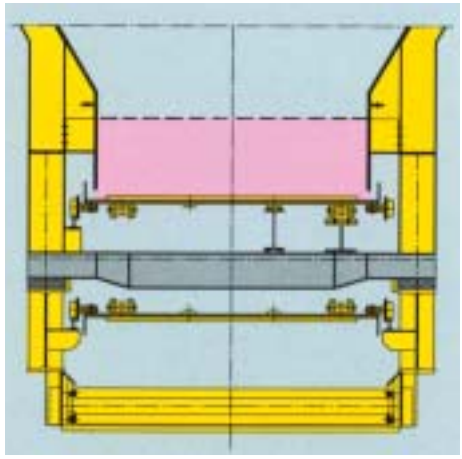


Apron Feeder, type BPB-SF with fixed rollers

Dumping Station

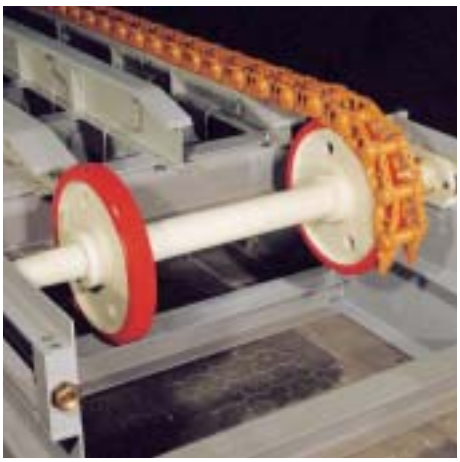


Apron Feeder, type BPB_SF



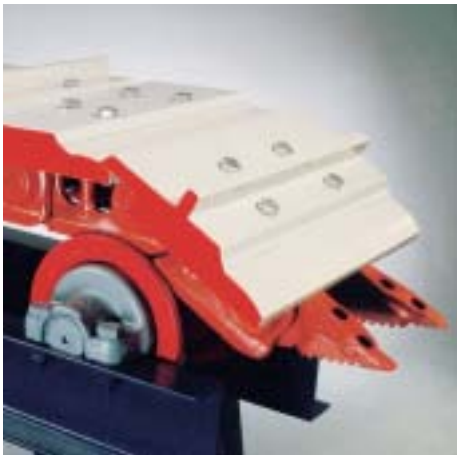
Apron Feeder, type BPB-S

Arched plate conveyor, type BPB-S type BPB-SF

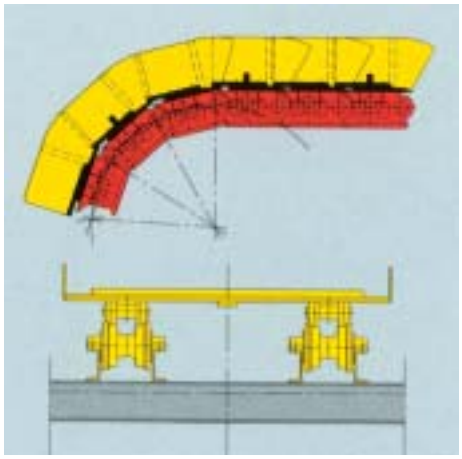


Tensioning shaft with untoothed guide wheels

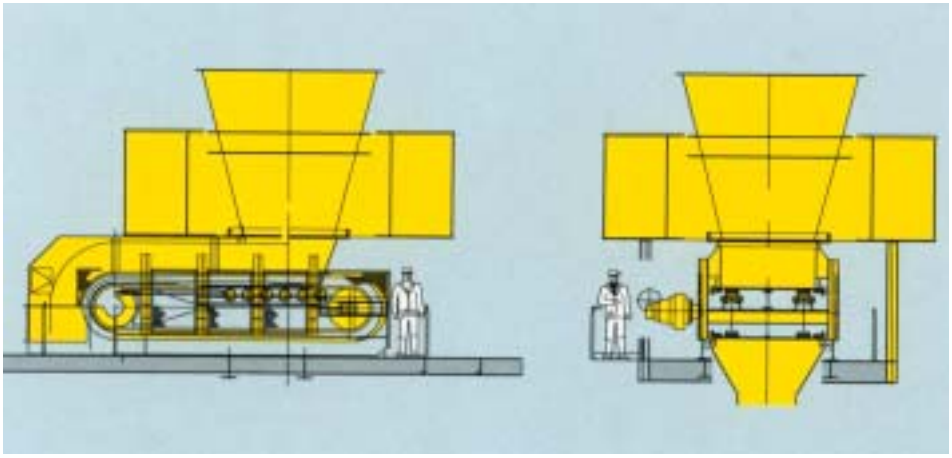
Fixed rollers for type BPB-S



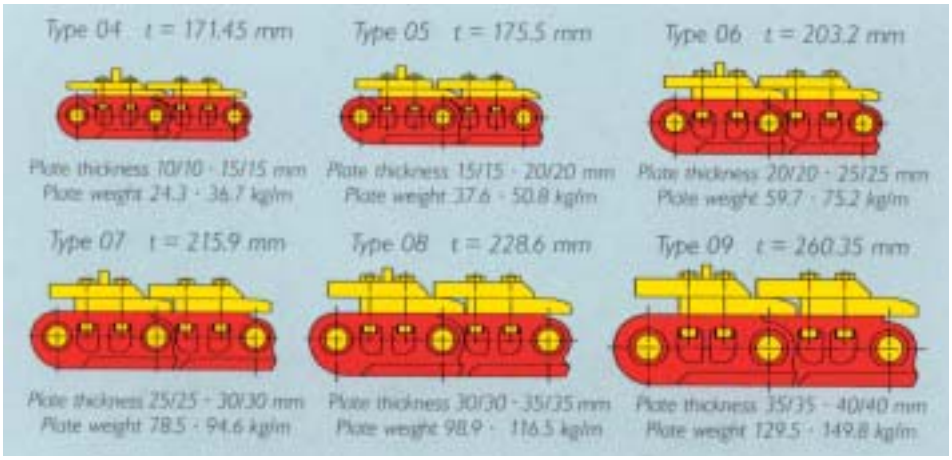
Apron Feeder type BPB-SF



Apron Feeder type BPB-SF with fixed rollers



Hopper discharge combination of type BPB-S and BPB-SF



Chain-plate-combination for type BPB-S and type BPB-SF

The chain carrying rollers designed for high impact loads are fitted with anti-friction bearings. Arranged at narrow intervals in the feeding area, they allow to reduce the number of impact relief girders or, depending on the application, to avoid the use of girders.

Crusher feeding generally requires the pan conveyor to operate with variable speed. Shaft mounted hydraulic drive units providing maximum torque in the lower speed range, are the most suitable solution. Drive units with bevel spur gear and electric motor are generally frequency controlled.

If the material loaded onto the conveyor contains large rocks, high impact loads need to be taken into account. To reduce these point loads, the impact relief girders and the roller supporting structure are connected by means of cross bars to form impact relief tables. In addition, shock absorbers are fitted in-between the cross bars and the conveyor supporting structure, hence avoiding possible distortion of the conveyor plates.

Spillage material which in certain cases is likely to accumulate underneath the apron feeder, can be recycled into the process with a cleaning scraper chain. The spillage fines by-pass the crusher to be directed onto the conveyor arranged subsequent to the crusher. For certain cohesive materials tending to stick to the scraper bottom plate and difficult to move with the scraper flights, the cleaning conveyor can be designed as a belt conveyor.

Armoured chain conveyor, type PKF

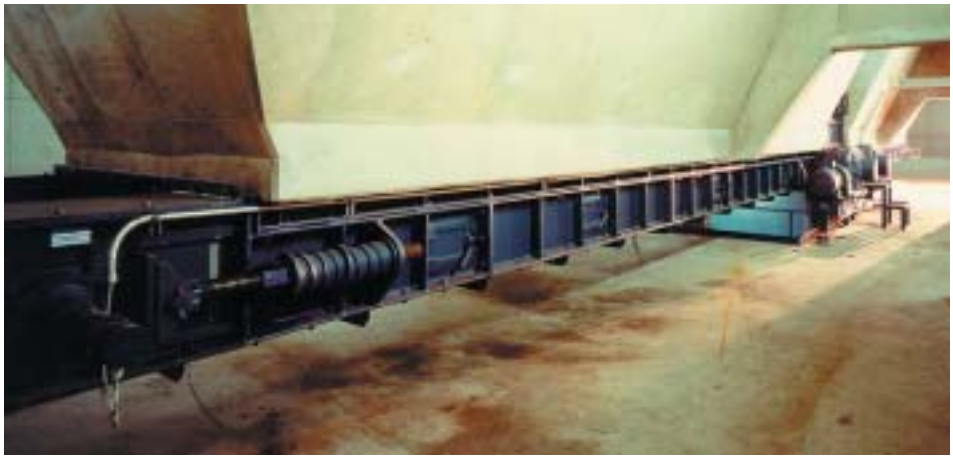
The traction element of the armoured chain conveyor consists of round link chains of either tempered or hardened steel depending on the application. The trough width is subject to the number of chain strands and flights and ranges between 600 and 2,600 mm. The variable number of chain strands provides the flexibility to adapt the conveyor to the outlet flange size of the hopper.

Chains and flights convey the material in the upper run across a wear-resistant bottom plate. Material falling from chains and flights in the return stations is recycled through the lower run to the upper run. No cleaning scrapers are required and the construction height of the armoured chain conveyor is consequently very low, hence reducing the overall space requirement.

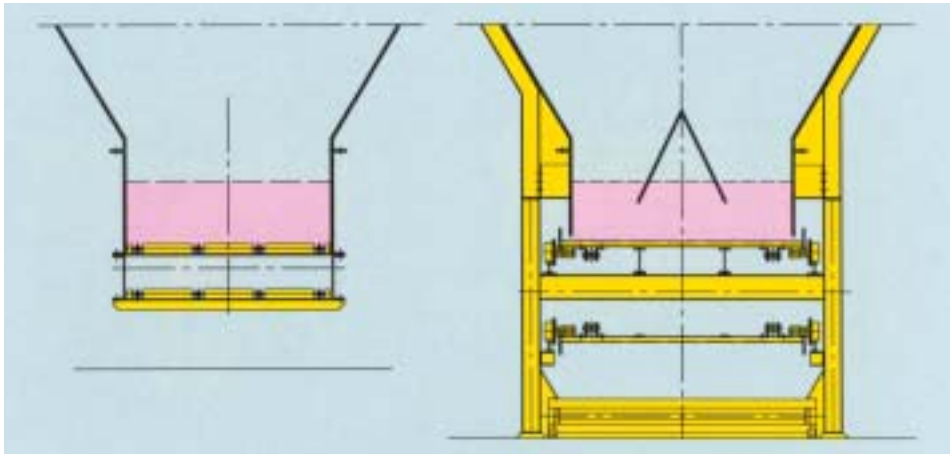
With its low construction height the armoured chain conveyor is primarily used for hopper discharge of crushed limestone or sticky raw materials such as chalk, gypsum, marl, clay or coal. Exact definition of the material properties are mandatory.

In order to obtain an even material flow for subsequent conveyors, a paddle wheel is arranged near the drive pulley. The paddle wheel runs at a speed of 20 to 50 rpm according to the properties of the conveyed material.

Armoured chain conveyor, type TKF



Hopper discharge with armoured chain conveyor



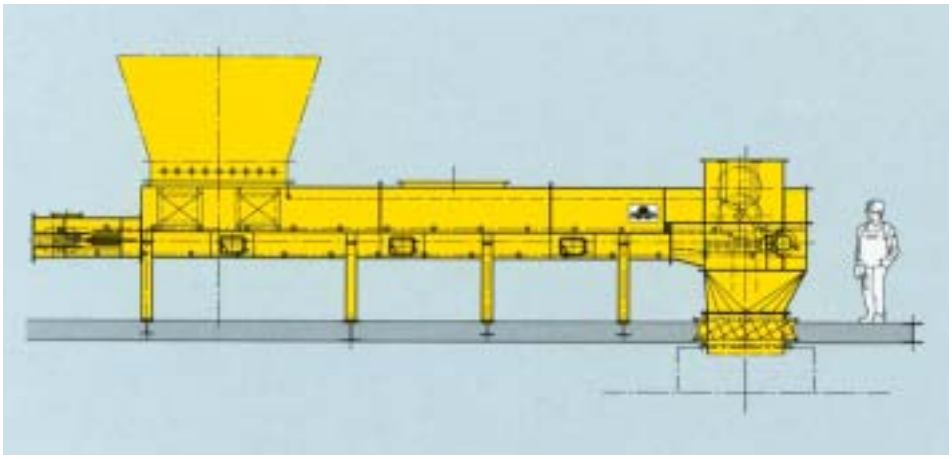
Comparison of construction height type PKF and type KZB -S with cleaning scraper

Proportioned hopper discharge with type PKF for mill feeding

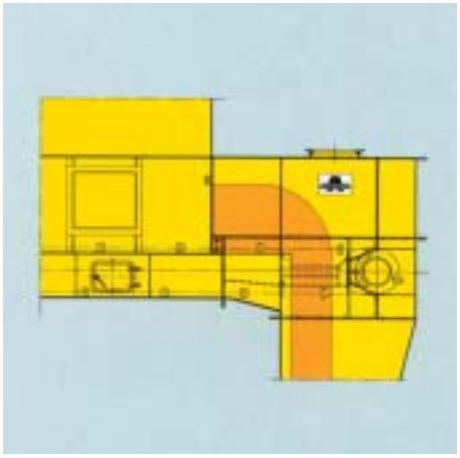
Armoured chain conveyor, type PKF

Mechanical plantary gear for type PKF

Haydraulic drive for type PKF



Pressure-tight armoured chain conveyor for vertical mill feeding



Prehead discharge for free flowing materials

Overhead discharge for sticky materials

Chart of conveying capacity armoured chain conveyor type PKF

Conveying trough			*Theoretival conveying capacity m³/h*			
Trough width		*Standard layer height*	*Conveying speed (m/s)*			
(mm)		*H (mm)*	*0.05*	*0.10*	*0.15*	*0.20*
Two strands	*600*	*300 +/- 100*	*32 +/- 10*	*64 +/- 21*	*97 +/- 32*	*129 +/- 43*
	700	*400 +/- 100*	*50 +/- 12*	*100 +/- 25*	*151 +/- 37*	*201 +/- 50*
	800	*400 +/- 100*	*57 +/- 14*	*115 +/- 28*	*172 +/- 43*	*230 +/- 57*
Three strands	*1.000*	*600 +/- 100*	*108 +/- 18*	*216 +/- 36*	*324 +/- 54*	*432 +/- 72*
	1.200	*600 +/- 100*	*129 +/- 21*	*259 +/- 43*	*388 +/- 64*	*518 +/- 86*
	1.400	*800 +/- 100*	*201 +/- 25*	*403 +/- 50*	*604 +/- 75*	*806 +/- 100*
Four strands	*1.400*	*800 +/- 100*	*201 +/- 25*	*403 +/- 50*	*604 +/- 75*	*806 +/- 100*
	1.700	*1.000 +/- 100*	*306 +/- 30*	*612 +/- 61*	*918 +/- 91*	*1.224 +/- 122*
	2.000	*1.000 +/- 100*	*360 +/- 36*	*720 +/- 72*	*1.080 +/- 108*	*1.440 +/- 144*
Five strands	*1.800*	*1.000 +/- 100*	*324 +/- 32*	*648 +/- 64*	*972 +/- 97*	*1.296 +/- 129*
	2.200	*1.000 +/- 100*	*396 +/- 39*	*792 +/- 79*	*1.188 +/- 118*	*1.584 +/- 158*
	2.600	*1.000 +/- 100*	*468 +/- 46*	*936 +/- 93*	*1.404 +/- 140*	*1.872 +/- 187*

min. layer height 2,3 x max. particle size
max. layer height = trough width - 200 mm
Conveying speed 0-0,2 m/s at choice
The actual conveying capacity depends capacity on the particle size and the layer height chosen. Capacity reduction factor 0.9-1.

Conveying capacity PKF

The power to drive the armoured chain conveyor is calculated on the basis of the nominal load and the total friction forces resulting from bottom and wall friction and the friction angle of the conveyed material. The nominal load depends on the hopper's contents and geometry combined with the cross section of the outlet flange. Correct definition of the traction forces requires specific material data. These data may be determined by testing typical material samples in the AUMUND laboratory. A further prerequisite for correct determination of the traction forces is the observation of a minimum height for the material layer behind the hopper outlet. The height of the material layer, preset by a level control gate, depends on the grain size structure of the material and its flow properties. For bulk materials with a grain size of 0 to 30 mm and good flow properties a minimum layer height of 400 to 900 mm is required. If the material has poor flow properties, the layer level control at the hopper outlet must be set at a height of at least 600 to 800 mm to ensure proper discharge. The rated conveying capacity is preferably obtained with a conveying speed of 0.1 m/s. The subsequently low outlet speed of the gear unit requires a high reduction ratio generally achieved with a planetary gear or hydraulic drive unit. If required, a subsequent weighing unit in connection with a frequency controlled drive motor, a DC motor or a hydraulic drive may be installed to control the speed and maintain the discharge capacity at a constant rate.

When handling humid or cohesive bulk materials, the armourd chain conveyor discharges the material like a belt conveyor, i.e. behind the drive pulley. For fine and free flowing materials such as cement clinker or gravel-shaped raw material, the discharge point is located in front of the drive pulley. With this arrangement, discharge is made through the lower run of the conveyor and the chains are protected from the material by means of roof-shaped hoods.

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